

REPORT OF WORKING GROUP 23 ON *COMPARATIVE ECOLOGY OF KRILL IN COASTAL AND OCEANIC WATERS AROUND THE PACIFIC RIM*

The Working Group on *Comparative Ecology of Krill in Coastal and Oceanic Waters around the Pacific Rim* (WG 23) held its third meeting on October 24, 2010, from 0900–1230 h under the chairmanship of Dr. William Peterson who welcomed the members of the Working Group who were present as well as visitors (WG 23 *Endnote 1*), and shared apologies for those unable to attend.

AGENDA ITEM 2

Agenda additions and/or changes

The Chairman asked if there were any additional change to the agenda. The only item offered was the need to discuss where we could to dinner that evening. The meeting agenda can be found in *WG Endnote 2*.

AGENDA ITEM 3

Country reports

Reports from each PICES member country on progress during the past year were given. These reports were to include a variety of items including (1) status of metadata describing data which exists (which data can be easily shared for synthesis papers); (2) publications to be included in our publications data base; (3) status of the idea of having portions of papers written in other languages translated into English; (4) potential for collaborative research in the near future; (5) TOR # 5 – status of Working Group members' work with modelers.

Canada

Dr. David Mackas summarized the extent of krill sampling in Canada, carried out by four programs. First, the ocean sampling that his group has been doing for a number of years was summarized. This, the “IOS Time Series” continues with 3–6 surveys per year, with sampling off southern Vancouver Island, northern Vancouver Island and Hecate Strait. Cruises are most often in May/June, August/September, depending on the availability of ship time. Sampling includes bongo tows during both day and night from which biomass per square meter is calculated. Another important time series is the one conducted by Dr. Ron Tanasichuk (Pacific Biological Station). He samples in Barkley Sound, with 10 surveys per year since 1991. Samples are processed chiefly for krill which are catalogued by length, weight, sex, maturity, gonad weights, and larval stage. Third, surveys also take place in the Strait of Georgia. These have been intermittent since 1968; the nighttime samples have been analyzed for euphausiids. Ms. Moira Galbraith (Institute of Ocean Sciences) maintains the database. Grad student Lingbo Li (University of British Columbia) has been analyzing the data from these samples and reports that there appears to be a big drop in the biomass of *Euphausia pacifica* in Strait of Georgia and an increase in *Thysanoessa spinifera* over the past 10 years. Finally, the cabled observatories, the NorthEast Pacific Time-Series Undersea Networked Experiments (NEPTUNE) and the Victoria Experimental Network Under the Sea (VENUS) projects include a 125 kHz echosounder (single frequency), and “krill” signals are being analyzed by Mei Sato (University of Victoria graduate student) with Dr. John Dower (University of Victoria).

China

No report was available.

Japan

Dr. Yuki Okazaki reported on several activities. First, information on the vertical distribution of early life stages of *E. pacifica* was presented at the PICES/ICES/FAO Symposium on “*Effects of climate change on fish and fisheries*” held in Sendai, Japan, in April 2010. Second, they have begun to do some feeding experiments on adult krill during their cruises, with the first experiments carried out in June 2010 in the Oyashio. In a related effort, they will use the Odate/NORPAC net collections to look at eggs and larvae of *Euphausia pacifica*. Pilot studies are underway. They have also been looking at samples from the A-Line (2001–2008), PH Line (1980–2000) and the Saury surveys (2001–2007). They have found that euphausiid larvae were mostly found at stations with a depth of ~100 m and temperature < 12°C. Larvae were most abundant May/June coincident with phytoplankton blooms at that time of the year. Calyptopis and furcilia densities are similar in shelf and offshore waters. For much of this work, collaborations have been initiated with Dr. Tomohiko Kikuchi (Yokohama National University) and his PhD student. It is possible that collaboration will soon be established with Dr. Yoshinari Endo (Tohoku University) on krill and climate change. Finally, Dr. Okazaki expressed interest in working with the Peterson lab on population genetics of *Euphausia pacifica*.

Korea

Dr. Se-Jung Ju reported that there are many samples available from Korean waters that can be analyzed for krill eggs, larvae, juveniles and adults, including bi-monthly samples collected by the NFRDI, since 1968. However, he noted that many samples do not look good due to drying out. KORDI samples the East Sea and East China Sea in spring and summer and there are opportunities for others to join these cruises to sample euphausiids and to conduct experiments on living animals. He noted that Korean scientists tried some live animal experiments but without much success. They incubated 35 females but only 2 spawned 103 and 136 eggs per female, respectively. He is also doing lipid analysis on some krill collected from recent cruises.

Dr. Ju also presented an overview of studies of krill life cycles in the Yellow Sea Cold bottom water. By studying the acoustically-derived scatter layer, it was determined that the migration speeds of the krill scattering layers were 0.87 m day (downward at dawn) and 0.74 m day (upwards at night) in spring. Rates were different during summer: 0.44 m day (down) and 0.49 m day (up) in summer. In summer they only migrated to the base of the mixed layer where the water is still cold and where the Chl maximum is found.

Future work will include studies of the feeding ecology of krill using trophic lipid markers. Acoustics data from daytime suggests that adults are living on the bottom during the day. Thus it might be interesting to attempt to sample the adults with bottom sampling nets. Future work will also include two cruises per year, spring and summer, and these will involve net tows, acoustics for DVM, and additional lipid work.

To date, Korean scientists have published about 8 papers, 3 of which are in Korean.

Russia

No report was available.

U.S.A.

Sampling along the Newport Line is continuing every two weeks; the Peterson lab initiated feeding experiments on *Euphausia pacifica* and work was being carried out by a Chinese Ph.D. student, Xiuning Du. Dr. Peterson also summarized many of the items discussed in the following agenda items.

AGENDA ITEM 4

Progress report on *Euphausia pacifica* synthesis paper

Ms. Leah Feinberg (Oregon State University) presented a report on the synthesis of *Euphausia pacifica* brood sizes. This paper will be similar to one published in 2006 by Dr. Jaime Gómez-Gutiérrez (CICIMAR) and

others on *Euphausia pacifica* where brood size as a function of body length were compared using data from Puget Sound (Ross), the Sea of Japan (Iguchi) and Oregon (Peterson lab). She has updated that paper using data from the Oregon coast 2003–2007 (n = 368), the Gulf of Alaska (n = 60), the Southern California CalCOFI region (Decima, n = 84), and the Oyashio (Okazaki, n = 59). She has some data from the Yellow Sea (from Se-Jung Ju) but is still waiting for some data from Dr. Song Sun (China). She also needs to standardize the lengths (some people use total length, others body length). She is finding the same dome-shaped relationship as before, but with many more data points.

AGENDA ITEM 5

Using Zotero as a way of sharing published papers

WG 23 discussed the use of this tool as a way to store pdf files of published papers and other documents on the PICES website. Dr. Harold Batchelder arranged a meeting with an Oregon State University librarian and the Peterson lab to discuss with her the legal issues of posting pdf files of scientific papers to a WG 23 website. She suggested using Zotero which is a free, easy-to-use Firefox extension to help users to collect, manage, cite, and share research sources. According to the Zotero webpage (www.zotero.org), it lives right where you do your work—in the web browser itself. Zotero is able to link citation information which has been entered to online electronic archives provided by the publishers, and may serve as the best way for providing access to publications. WG 23 agreed that the tool seems like a good way to share data and publications.

AGENDA ITEM 6

Status of new project to characterize genetic structure of *Euphausia pacifica*

At the time of the meeting, it was reported that Dr. Peterson had hired a post-doc at the Hatfield Marine Science Center (Dr. Mattias Johansson) to begin some exploratory work on the population genetics of krill. Considerable progress has been made and will be reported on at PICES-2011 in Khabarovsk, Russia.

AGENDA ITEM 7

Report on the potential for using measurements of hepato-pancreas size as an index of condition in *Euphausia pacifica*

As with the genetics work, it was reported that we had only the potential to add measurements of the hepato-pancreas to our tool box. The Peterson lab hosted a young Chilean scientist, Ramiro Riquelme, during August 2010 in Newport, to collect living krill during our biweekly cruises and to measure the size of the hepato-pancreas. We learned that this appears to be a promising index of recent krill growth.

AGENDA ITEM 8

Discussion of TOR # 7

WG 23 discussed whether or not there was enough new information to justify organizing a krill symposium or a krill Topic Session for PICES-2011 in Khabarovsk, Russia. It was decided to not pursue this.

AGENDA ITEM 9

Summary of mid-term activities

A summary of activities of WG 23 following PICES-2009 in Jeju, Korea, and preceding PICES-2010 is reported in the following:

WG 23-2010

1. A joint Korea–U.S. research cruise was scheduled for April 11–18, 2010 with the purpose of training Korean scientists on how to carry out ship-board laboratory studies of krill egg production, molting and grazing. Unfortunately the cruise was cancelled (on April 7) because the research ship was requested to help investigate the causes of the sinking of a Korean Navy ship at the end of March. Ms. Tracy Shaw and Dr. Peterson were to have joined this cruise, led by Dr. Se-Jong Ju, all of whom are Working Group members.
2. Dr. Peterson was allocated some start-up funds to begin study of pan-Pacific variations in genetic structure of our study organisms, *Euphausia pacifica*. A recent doctoral student, Mattias Johansson, was hired to begin this work.
3. Dr. Ju has collected *Euphausia pacifica* from Korean waters (both east and west sides of Korea) and has preserved them in alcohol for later analysis of genetic structure. Ms. Shaw has done the same with *E. pacifica* collected from the Bering Sea, so we now have specimens from three widely-separated locations.
4. The Peterson lab hosted a Chilean graduate student, Ramiro Riquelme, this summer. We learned from him how to do measurements of hepato-pancreas length as a measure of the euphausiid condition. [This technique was reported on at the WG 23 meeting during PICES-2010 (see Agenda Item 7) with the hope that other members of the Group will adopt this method in their future research.]
5. The Peterson lab continues to host Chinese graduate student, Xiuning Du (from Ocean University of China, in Qingdao), who is working on feeding rates of *Euphausia pacifica* through microscopic counts of phytoplankton and ciliates removed in control vs. feeding containers. [She was awarded Best Oral Presentation for her talk on “Feeding rates of adult *Euphausia pacifica* on natural particle assemblages in the coastal upwelling zone off Oregon, USA” for a BIO-sponsored Session at PICES-2010.]
6. A special issue of selected papers on krill from the 4th International Zooplankton Production Symposium on “*Human and climate forcing of zooplankton populations*” first appeared online in *Deep-Sea Research II*, and those who have seen it have commented that it is really nice and well worth the wait. The hard-copy of the journal was published in April 2010 (*Deep-Sea Research II*, Vol. 57, Is. 7–8). Due to the untimely death of Dr. Ed Brinton, we decided to dedicate the Krill Special Issue in his honor. Elsevier Press agreed that it was appropriate so Dr. Mark Ohman (Scripps, U.S.A.) and Jaime Farber Lorda (CICESE, Mexico) wrote up a brief obituary.
7. Tracy Shaw *et al.*’s paper on “Growth of *Euphausia pacifica* in the upwelling zone off the Oregon coast”, pp. 584–591, was published in the krill special issue of *Deep-Sea Research II* in which she summarized and synthesized all published growth rate data on *Euphausia pacifica*.
8. Drs. Peterson and Kazuaki Tadokoro organized a copepod and krill workshop titled, “*Examining the linkages between physics and fish: how to zooplankton and krill data sets improve our understanding of the impacts of climate change on fisheries?*” on April 25, 2010 at the PICES/ICES/FAO Symposium on “*Effects of climate change on fish and fisheries*” held in Sendai, Japan.
9. Dr. Yuju Okazaki arranged a tour of the Tohoku National Fisheries Research Institute laboratory following the Sendai symposium (April 2010) and, despite the rainy weather on Saturday following the symposium, the tour did take place.

WG 23 Endnote 1**WG 23 participation list**Members

Michael J. Dagg (U.S.A.)
 Sejong Ju (Korea)
 Michio J. Kishi (Japan)
 David L. Mackas (Canada)
 Yuji Okazaki (Japan)
 William T. Peterson (U.S.A., Chairman)

Oberservers

Xiuning Du (China)
 Leah Feinberg (U.S.A.)

WG 23 Endnote 2**WG 23 meeting agenda**

1. Welcome and introduction
2. Agenda additions and/or changes
3. Country reports on progress during the past year on action items identified at PICES-2009
 - 3.1 metadata describing data which exists (which data can be easily shared for synthesis papers);
 - 3.2 publications to be included in our publications data base
 - 3.3 status of the idea of having portions of papers written in other languages translated into English
 - 3.4 potential for collaborative research in the near future
 - 3.5 TOR # 5 – status of your work with modelers
4. Report on progress on synthesis paper on *Euphausia pacifica* brood sizes
5. Discussion (and possible demonstration) of use of Zotero as a way of sharing published papers
6. Report on status of new project to characterize genetic structure of *Euphausia pacifica* from specimens collected off Oregon, Bering Sea and waters adjacent to the Korean peninsula
7. Report on the potential for using measurements of size of the hepato-pancreas as an index of condition in *Euphausia pacifica*.
8. Discussion of TOR # 7
9. Summary of mid-term activities